Corn Stalk Quality

Many different stresses to corn plants can lower stalk quality, with the result that stalk problems occur in some fields each year throughout North America. Drought stress, reduced sunlight, insect and disease pressure, and hail damage are stresses that can result in poor stalk quality. Even good growing conditions can lead to stalk problems when followed by a less favorable environment. Cropping history, soil fertility, hybrid genetics and micro-environment effects can heighten the problem in certain fields. Growers should monitor their fields as harvest approaches to identify stalk quality problems, and if necessary, prepare to harvest before field losses occur.

Photosynthesis and Carbohydrate Translocation

Through photosynthesis, leaves of corn plant capture sunlight and carbon dioxide (CO₂) to produce sugars (photosynthates), which are directed to the actively growing organs of the plant. Early in plant development, sugars move to the roots, where they are converted to structural carbohydrates and proteins. As plants continue to grow, sugars are directed to the stalk for temporary storage.

Following pollination, kernel development places a great demand on the plant for carbohydrates. When the demands of the developing kernels exceed the supply produced by the leaves, stalk and root storage reserves are tapped.

Environmental stresses, such as drought and low available sunlight, decrease photosynthetic production and force plants to extract even more stalk carbohydrates, which preserves grain fill rates at the expense of the stalk. Disease lesions, insect feeding and hail damage also limit photosynthetic production by reducing the functional leaf area of the plant.

Stalk Rot / Plant Stress

Stressed plants make less sugar. Stresses include disease, drought, lack of sunlight, high plant density, etc.

Developing ears take priority. Amount of sugars required depends on kernel number (yield potential).

Root and stalk tissue have lower priority. Under stress, these tissues receive less sugar and weaken. Stalk rot fungi infect and initiate disease.

To reduce stalk rot, reduce stress.

As carbohydrates stored in the roots and stalk are mobilized to the ear, these structures begin to decline and soon lose their resistance to soil-borne pathogens. High temperatures increase the rate at which the fungi invade and colonize the plant. Though pathogens play a key role in stalk rot development, it is primarily the inability of the plant to provide sufficient photosynthates to the developing ear that initiates the process.

Stalk Rot Often Begin as Root Rot

Stalk-rotting fungi inhabit the soil in the root zone of corn plants, surviving on discarded cells and nutrients excreted by the roots. They are prevented from invading the roots and stalk by metabolites produced in the plant. Though unable to overcome healthy living tissue, these opportunistic fungi rapidly invade weakened and dying roots as the plant redirects carbohydrates from the roots to kernels. After the roots are colonized, the infection spreads to the stalk (Dodd, 1983).

As vascular tissues in the plant become plugged by fungal mycelial growth, water supply to the plant becomes restricted. Wilting and premature death of the plant eventually follows. External discoloration of the lower stalk eventually becomes evident. The structural integrity of the stalk is diminished by this decay, and the plant is susceptible to lodging. Storms and high winds provide the forces needed to topple the weakened stalks.

The Growing Environment

Almost any stress applied to the plant will reduce photosynthesis and resultant sugar production in the leaves.

Drought Stress - The decrease in photosynthetic rates due to drought stress has been well documented in research studies. Water relations within the plant and CO₂ and O₂ exchange are directly affected. In addition, if leaf rolling occurs during drought, the effective leaf surface for collection of sunlight is reduced.

In research studies that withheld water from plants beginning at the mid-grain-fill stage, photosynthesis was eventually shut down (Westgate and Boyer, 1985). Subsequent grain development depended entirely on stalk carbohydrate reserves.

Reduced Sunlight - Photosynthesis is most efficient in full sunlight. Studies show that the rate of photosynthesis increases directly with intensity of sunlight. In fact, photosynthesis rates are reduced more than 50% on an overcast day compared to a day with bright sunshine (Moss et. al., 1960). Prolonged cloudy conditions during ear fill often result in severely depleted stalk reserves.

Reduction of Leaf Area - Any reduction in leaf area will limit total photosynthesis. Leaf area may be reduced due to hail, frost, disease lesions, insect feeding or mechanical injury. Whenever functional leaf area is reduced prior to completion of ear fill, stalks will be weakened.

Early Favorable Conditions Followed by Stress - If favorable conditions exist when the number of kernels per ear is being established (V10 to V17), the eventual demand for photosynthates will be large. Each potential kernel represents an additional requirement for translocatable sugars from the plant. If stress conditions develop during ear fill that render the plant unable to produce enough sugars, stalks will suffer.
Table 1. Comparison of kernel numbers between plants with rotted stalks and adjacent plants with healthy stalks.*

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Hybrids Tested</th>
<th>No. of Plant Pairs</th>
<th>Rotted Stalks</th>
<th>Adjacent Healthy Stalks</th>
<th>Diff.</th>
<th>No. of Kernels / Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 1</td>
<td>40</td>
<td>112</td>
<td>562</td>
<td>495</td>
<td>67**</td>
<td>67**</td>
</tr>
<tr>
<td>Year 2</td>
<td>30</td>
<td>65</td>
<td>648</td>
<td>587</td>
<td>61**</td>
<td>61**</td>
</tr>
</tbody>
</table>

* From Dodd, 1980. ** Significant at the .001 prob. level.

Soil Fertility

Research studies have documented that soil fertility has a profound effect on stalk quality. Most notable are studies which show that a combination of high nitrogen and low potassium can severely reduce stalk quality. Researchers suggest that yearly applications of N and K (actual N, K as K₂O) should be approximately at the ratio of 1 to 1 for favorable balance in the corn plant and to reduce the risk of stalk rot and stalk breakage.

High nitrogen (N) is associated with greater kernel number, which increases the demand for carbohydrates to the ear. Higher N also aids the movement of these carbohydrates out of the stalk and into the ear by increasing the rate of translocation within the plant.

The role of potassium (K) in preventing premature plant death has long been established. Potassium functions in the building of leaf and stalk tissue, as well as regulating water movement within the plant. Increases in K have been associated with increased photosynthetic rate.

Hybrid Differences / Foliar Fungicide Applications

Carbohydrate Partitioning - Some hybrids naturally partition more carbohydrates to the stalk. Though useful in a poor stalk quality year, that trait may limit yield potential in a more normal environment. As hybrids are developed, researchers must be careful to select those with highest harvestable yield potential across many years and environments. Too much emphasis on stalk quality alone could result in lower yield potential most years. Many carefully selected hybrids with very good stalk quality may appear inadequate during a one-year-in-ten stalk-lodging event.

Leaf Disease Resistance - Hybrids prone to leaf diseases may lose significant leaf area, weakening the stalks. For this reason, foliar fungicide applications may reduce stalk lodging in years with high levels of fungal leaf diseases. DuPont Pioneer rates its hybrids for resistance to major leaf diseases to aid customers in their decisions about fungicide applications.

Stalk Rot Resistance - Susceptibility to specific stalk rot pathogens also increases the stalk-lodging risk. Pioneer provides hybrid ratings for resistance to major stalk rots.

Other Effects

Micro-Environments - Oftentimes, even small differences between fields or between areas in the same field can determine whether corn stands or lodged. Differences in soil fertility, soil moisture, plant-to-plant spacing, insect feeding or wind gusts can push plants past the lodging threshold. These effects are difficult to predict; however, scouting in the fall can identify problem fields, and early harvest can reduce field losses.

Plant Population - Multi-year research studies show that stalk lodging is increased only slightly at higher plant populations. For example, a summary of DuPont Pioneer research from 35 high-lodging environments from 2004 to 2007 showed that percent stalk lodging increased only about 1% for each 2,000 plant/acre population increase.

Reducing Harvest Losses Due to Stalk Lodging

Careful scouting and harvesting fields according to crop condition can help prevent field losses due to low stalk quality. Corn loss potential should be weighed just as heavily as grain moisture in deciding which fields to harvest first. Scouting fields approximately two to three weeks prior to the expected harvest date can identify fields with weak stalks predisposed to lodging. Fields with high lodging potential should be slated for early harvest.

Weak stalks can be detected by pinching the stalk at the first or second elongated internode above the ground. If the stalk collapses, advanced stages of stalk rot are indicated. Another technique is to push the plant sideways 15 to 20 inches at ear level. If the stalk crimps near the base or fails to return to the vertical position, stalk rot is indicated. Check 20 plants in five areas of the field. If more than 10 to 15% of the stalks are rotted, that field should be considered for early harvest.

DuPont Pioneer Research Emphasizes Stalk Quality

DuPont Pioneer corn breeders and plant pathologists use aggressive techniques to weed out hybrids with poor stalk quality, including manual and mechanical push tests that mimic the forces of wind on corn plants. In addition, plants are inoculated with stalk rot organisms where appropriate to help ensure that susceptible genotypes do not escape detection. Plant pathologists monitor disease incidence and assist breeders in their efforts to inoculate, screen and characterize products. Research trials conducted by corn breeders are designed to measure product performance for all important traits across a wide range of growing conditions.

Pioneer IMPACT™ plots further test product performance, including characterization of stalk quality, thus determining proper placement of new product releases. Pioneer uses information from both breeder and IMPACT plots to develop stalk lodging ratings for all its hybrids to aid customers in selecting appropriate hybrids for their fields.